INTERPRETATION OF SEA ICE IN SATELLITE IMAGERY (EXTENDED ABSTRACT)

Nobuo ONO

The Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo 060

Knowledge of arctic and antarctic sea ice features which include the extent of and the seasonal variation in sea ice as well as distributions of leads and polynyas is essential to studying the role of sea ice in the global climate or the effect of pack ice on polar marine structures. Remote sensing from a satellite provides the most useful information on features of sea ice over a large ice extent. For example, the Nimbus-5 electrically scanning microwave radiometer (ESMR) shows that the difference between the maximum and the minimum area of antarctic sea ice throughout the year exceeds the area of Antarctica and that a huge polynya appears in the winter ice region in the vicinity of the Weddell Sea.

Satellite data from the advanced very high resolution radiometer (AVHRR) of TIROS-N/NOAA-6 have been received at Syowa Station, Antarctica, since February 1980. The resolution of AVHRR is about 1.1 km vertically under the satellite. This is compared in Table 1 with the resolutions of Nimbus-5 ESMR and Landsat MSS, multi-spectral scanner.

Table 1. Resolution of satellite data.

Satellite	Nimbus-5	TIROS-N/NOAA-6	Landsat-2 & 3
Instrument	ESMR	AVHRR (4 ch)	MSS (4 ch)
Wavelength	1.55 cm	0.55–12.5 μm	0.5–1.1 μm
Resolution	30 km	1.1 km	80 m

ESMR: Electrically Scanning Microwave Radiometer.
AVHRR: Advanced Very High Resolution Radiometer.
MSS: Multi-Spectral Scanner.

The size of an ice floe appearing in a low ice-concentration area such as a marginal ice zone is considered smaller than the resolution of the satellite data. In order to interpret image values of low ice-concentration area, it is therefore necessary to find out which element of the features of the ice area has the predominant influence in determining the apparent ice area in the satellite data.

In the present study the Landsat MSS data were used as the first step of this effort to find this out. The resolution of the MSS is about 80 m. The sea ice features derived from the Landsat data were compared with simultaneous images

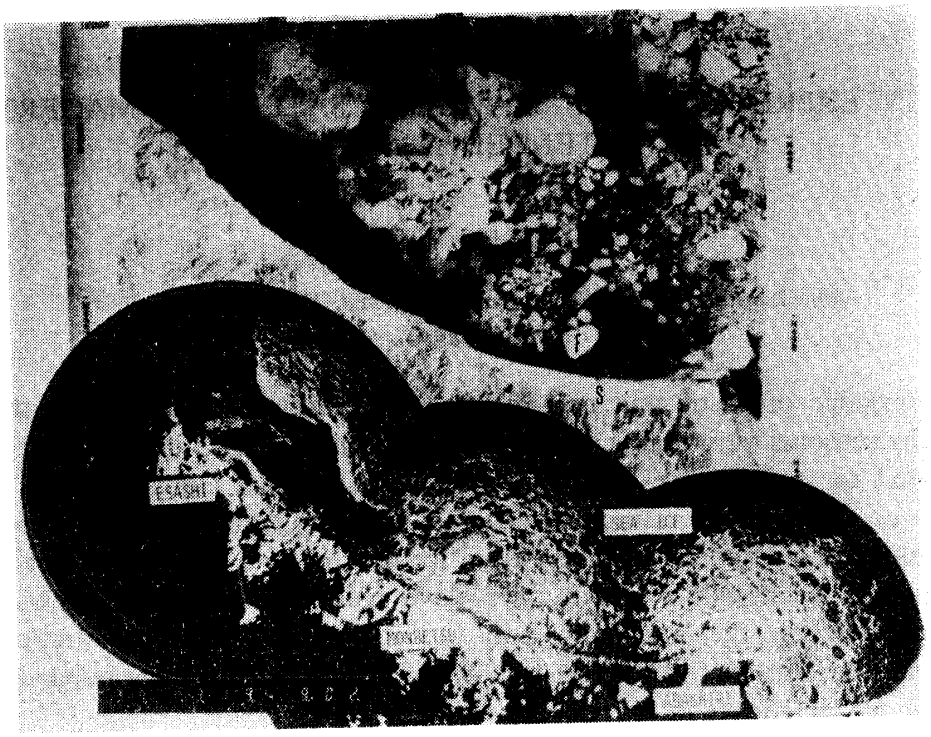

Fig. 1. A pair of simultaneous images of Landsat MSS (band-7) and of the sea ice radar off the coast of Hokkaido. S: Lagoon Saroma-ko, F: estimated flat ice.

of the sea ice radar taken on the Okhotsk sea coast of Hokkaido. The radar is characterized by a frequency of 5540 MHz, beam width of one degree and pulse width of one micro second, having therefore a resolution of 150 m.

Shown in Fig. 1 are a Landsat MSS band-7 image and a simultaneous radar image as a pair. A fairly good agreement between both images is recognized in the shapes of the sea coast and ice edges of pack-ice fields. The lagoon Saroma-ko appears dark in the radar image, while it is entirely covered with ice in the Landsat image. An ice-covered area marked F off Yubetsu at the west end of the lagoon is considered very flat because the dark area appears in the center of this ice area

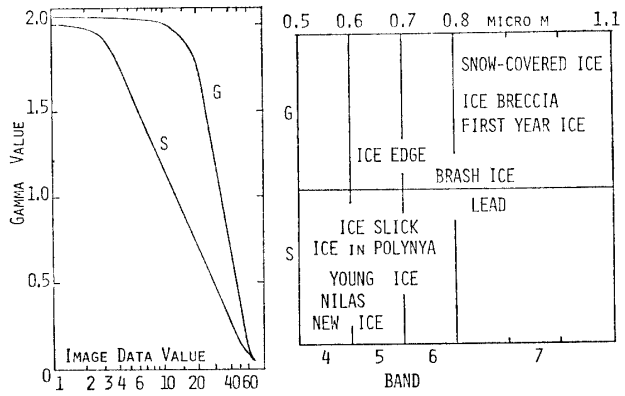

Fig. 2. Appropriate combinations of a suitable Landsat MSS band and a suitable data treatment of image values for the individual stage of sea ice development.

on the radar image. An examination of this ice area using the computer compatible tape (CCT) of the Landsat image shows that the data of this ice area consist of pixels of high image values compared with those of surrounding ice areas.

An area of 40% or more overlaps between a Landsat image of the southern Okhotsk sea and the neighboring Landsat image taken 24 hours later in the consecutive path. Sea ice dynamics such as the drift and the deformation of a pack ice field within 24 hours is observed in this overlap area. The new ice forming in a lead opened during this interval which is interpreted to exist in the overlap area can be used as a known feature for a comparison between images of visible and infra-red bands or with other simultaneous remote sensing data.

For the interpretation of Landsat MSS images concerning various features in sea ice developments, appropriate combinations of a suitable band and suitable data treatment of image values are summarized in Fig. 2. It follows from the figure that a pair of images, one based on the standard processing of a visible band and the other on the high-level enhanced processing of a near-infrared band, are needed to interpret the Landsat MSS images of various kinds of ice fields.

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